U.S. Department of the Interior
U.S. Geological Survey

MERCURY IN STREAMBED SEDIMENT AND AQUATIC BIOTA IN THE UPPER SNAKE RIVER BASIN, IDAHO AND WESTERN WYOMING, 1992

NAWQA
Fact Sheet

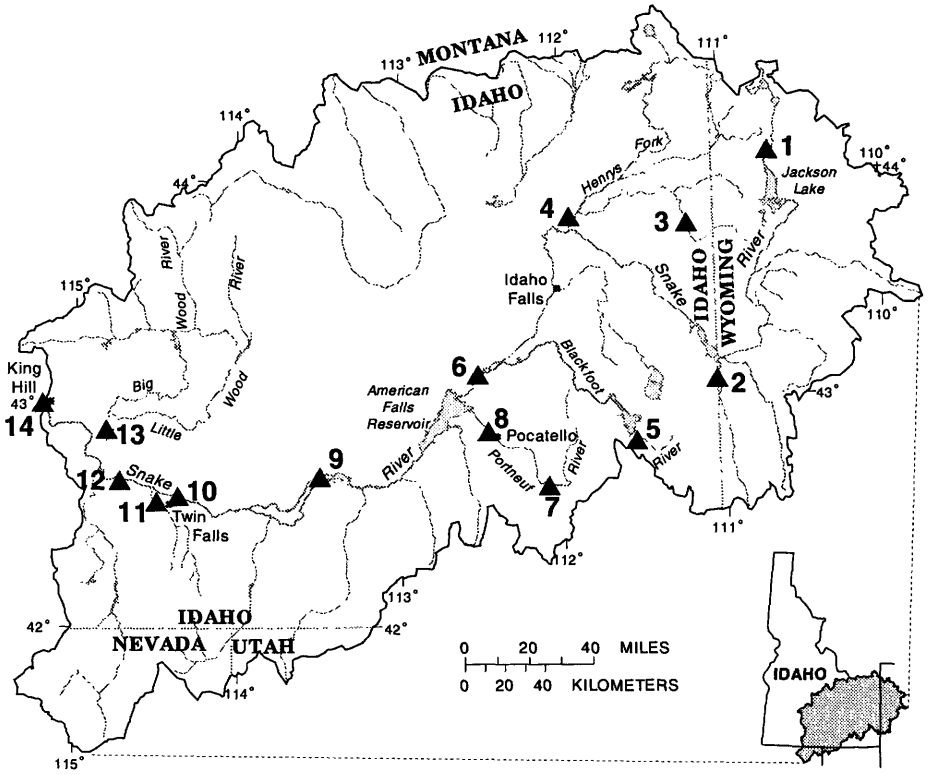

Figure 1. Bed sediment and tissue sample collection sites in the upper Snake River Basin, 1992.

Background

In 1991, the U.S. Geological Survey implemented the National Water-Quality Assessment (NAWQA) Program. Long-term goals of this program are to describe the status and trends in the quality of a large representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary natural and human factors that affect the quality of these resources. In meeting these goals, the program will produce a wealth of water-quality information that will be useful to policymakers and managers at national, State, and local levels. The upper Snake River Basin was among the first 20 NAWQA Program study units that began water-quality assessment.

A major component of the water-quality assessment is to identify the occurrence and distribution of contaminants in streambed sediment and aquatic biota tissue. In August and September 1992, bed sediment and biota tissue samples were collected at 14 sites in the upper Snake River Basin in Idaho and western Wyoming (fig. 1) to determine whether trace elements and synthetic organic compounds were present. Mercury was one of many trace elements analyzed in these samples.

Facts About Mercury

Studies of biological and contaminant data for surface water in the upper Snake River Basin have identified mercury as a contaminant of concern in aquatic biota. Mercury in biological tissue represents contamination from natural or anthropogenic sources because it has no known biological function. Mercury enters the environment from natural sources, such as weathering of minerals and rocks, and from activities associated with mining, agriculture, and industry. The most common natural source of mercury is cinnabar, a mineral ore that comprises mercury and sulfur. Where present in streams, mercury generally will occur at higher concentrations in bed sediment and biota than in the surrounding water.

Microorganisms can synthesize inorganic mercury compounds in bed sediment and water into methylmercury, which is the most bioavailable form of mercury and the most toxic form because concentrations accumulate in organisms and magnify in the food chain. Mercury is a known mutagen and carcinogen and can adversely affect reproduction, growth and development, behavior, and metabolism of organisms.

Nationwide monitoring by the U.S. Fish and Wildlife Service from 1978 to 1981 demonstrated that the highest mercury concentrations were in northern squawfish (*Ptychocheilus oregonensis)* from the Columbia River Basin in the Pacific Northwest. These elevated levels were attributed primarily to the presence of extensive natural cinnabar deposits and to mercury use associated with mining in this basin.

Elevated mercury concentrations in fish are of concern because of the direct health threat to humans and fish-eating wildlife. Although mercury concentrations have been reported in fish from American Falls Reservoir near Pocatello, Idaho, no health advisories or bans on fish consumption in the upper Snake River Basin have been issued to date (1994) as a result of environmental contaminants. Fish tissue data collected in 1994 by various State agencies in Oregon and Idaho indicated that mercury concentrations in the Snake River and some of its tributaries in southwestern Idaho and eastern Oregon are near or exceed State and (or) Federal criteria for consumption. Public health advisories for fish consumption have been issued as a result of these findings.

Study Approach

Bed sediment and biota sample collection sites in the upper Snake River Basin were selected in areas where contaminants would most likely occur. These areas include parts of the Snake River, particularly some of its major tributaries that are affected by cumulative point and nonpoint pollution sources. Sediment and biota collected at 14 sites that characterized major land-use activities and undisturbed conditions were sampled for mercury.

Trace elements in aquatic environments typically are associated with fine-grained sediments rich in organic materials. These sediments are actively transported, and associated contaminants can interact closely with bottom-dwelling organisms. Concentrations of trace-element contaminants were determined by analyzing composite samples of silt- and clay-sized particles (less than 63 microns in diameter) from surficial bed sediment (about 1 centimeter in depth).

Caddisfly larvae (fig. 2) and fish (suckers) are common in streams throughout the basin and can accumulate trace elements from environmental sources, so they were targeted as biological indicators of trace-element contamination. The net-spinning caddisfly (*Hydropsyche* sp.), which lives primarily in riffle habitats of rivers, was the common species collected for analysis of mercury concentrations in tissue. Where caddisfly larvae were not present in sufficient numbers at the Kimberly, the Buhl, and the King Hill sites on the main-stem Snake River, largescale

Figure 2. Caddisfly larvae (*Hydropsyche* sp.). (Enlarged approximately 12 X actual size)

suckers (*Catostomus macrocheilus*) were collected and their livers were analyzed for mercury concentrations. Even though mercury concentrations in caddisfly and fish liver tissues are not directly comparable, both types of tissue are good indicators of elevated mercury concentrations in aquatic environments.

Tissue samples consisted of either a composite of 200 to 500 individual caddisfly larvae or livers from 5 to 10 similar-sized adult largescale suckers. Trace elements associated with ingested material can elevate concentrations in aquatic insect samples. Accordingly, caddisflies were maintained for 4 to 6 hours in native water to purge gut contents before processing. Caddisflies were handpicked from rocks and other substrates, and fish were collected by electrofishing techniques. Individual fish were measured for length, weighed, and sexed. In addition, because a high incidence of external anomalies may indicate the presence of contaminants, all fish were examined for lesions, tumors, and other deformities.

Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory in Arvada, Colorado. Trace elements in bed sediment were analyzed at the Geologic Division Laboratory in Lakewood, Colorado. All concentrations were reported in micrograms per gram, dry weight. The minimum detection limits for mercury were 0.01 microgram per gram in bed sediment and 0.02 to 0.05 microgram per gram in tissue.

Findings

Mercury was detected in bed sediment at all 14 sites (figs. 3, 4). Detectable concentrations ranged from less than 0.02 to 0.09 microgram per gram, and the median was 0.05 microgram per gram. The highest concentration was from the Snake River near Buhl. The Canadian Ministry of Environment and Energy guidelines state that mercury concentrations in bed sediment should not exceed 0.2 microgram per gram for the protection of most bottom-dwelling organisms. All concentrations in bed sediment samples were below this guideline.

Mercury was detected in tissue samples at 10 sites in the upper Snake River Basin. Concentrations in caddisflies and largescale suckers ranged from 0.02 to 0.22 microgram per gram, dry weight (figs. 3, 4). According to the U.S. Fish and Wildlife Service, mercury concentrations should not exceed 0.1 microgram per gram, wet weight (equivalent to about 0.5 microgram per gram, dry weight, assuming 80 percent moisture in tissue), for the protection of fish-eating birds and wildlife. All concentrations in tissue samples were below this guideline. Generally, mercury concentrations in bed sediment and tissue increased downstream in the main-stem Snake River. The highest mercury concentrations in biota were in largescale suckers collected from the Snake River at King Hill. This mainstem site is affected by cumulative point and nonpoint sources of pollution. In addition, the Snake River sites in the lower end of the basin (Kimberly, Buhl, and King Hill) have more fine-grained sediment depositional areas for biota to be exposed to and ingest. Fish from all sites appeared to be in good health and had few external anomalies.

Mercury concentrations in bed sediment and tissue samples were below levels of concern for the protection of bottom-dwelling organisms and fish-eating birds and wildlife. Concentrations in samples from sites on the Snake River and tributaries were similar. Mercury concentrations in tissue of caddisflies and fish from the Snake River near Buhl and at King Hill and from the Portneuf River were slightly elevated. Because mercury accumulates in muscle tissue of fish, analyses of fish fillets from these sites would help determine the extent and severity of potential health risks to humans and wildlife.

During the NAWQA Program study, additional data on contaminants in bed sediment and biota tissue, water quality, habitat, macroinvertebrates, algae, and fish communities will be collected at these and other sites. These data will provide the necessary multiple lines of evidence to assess the relations between land use and water quality.

——*Terry R. Maret*

Selected References

Buhler, D.R., ed., 1973, Proceedings of a workshop on mercury in the western environment, Portland, Oreg., February 25–26, 1971: Corvallis, Oreg., Continuing Education Publications, 360 p.

Crawford, J.K., and Luoma, S.N., 1993, Guidelines for studies of contaminants in biological tissues for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 92–494, 69 p.

Eisler, Ronald, 1987, Mercury hazards to fish, wildlife, and invertebrates—a synoptic review: U.S. Fish and Wildlife Service Biological Report 85, v. 1, no. 10, 90 p.

Low, W.H., and Mullins, W.H., 1990, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the American Falls Reservoir area, Idaho, 1988–89: U.S. Geological Survey Water-Resources Investigations Report 90–4120, 78 p.

Lowe, T.P., May, T.W., Brumbaugh,W.G., and Kane, D.A., 1985, National Contaminant Biomonitoring Program—concentrations of seven elements in freshwater fish, 1978–1981: Archives of Environmental Contamination and Toxicology, v. 14, p. 363–388.

Persaud, D., Jaagumagi, R., and Hayton, A., 1993, Guidelines for the protection and management of aquatic sediment quality in Ontario: Toronto, Ontario, Ministry of Environment and Energy, 24 p.

For more information, please contact:

Chief, Upper Snake River Basin
NAWQA Program
U.S. Geological Survey
Water Resources Division
230 Collins Road
Boise, Idaho 83702-4520
(208) 387-1328

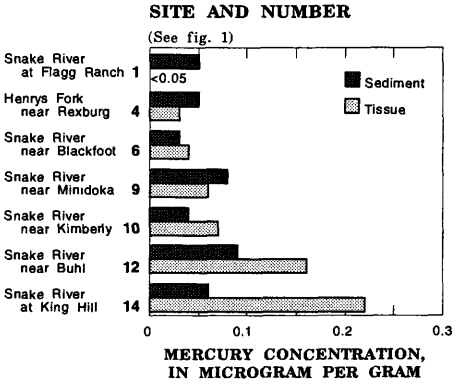

Figure 3. Mercury concentrations in bed sediment and tissue samples from main-stem sites.

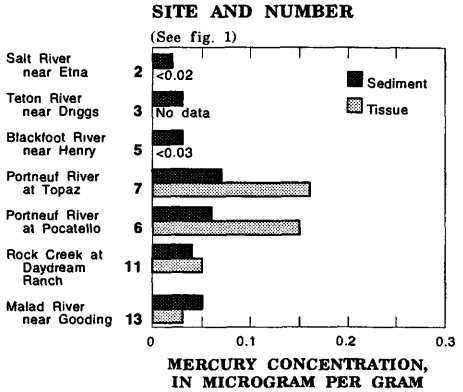

Figure 4. Mercury concentrations in bed sediment and tissue samples from tributary sites.